Claims

1. A method of communication using Orthogonal Frequency Division Multiplexing ('OFDM') comprising generating bit streams $b_n \in (0,1), n = 0,1,\ldots,K-1$ and the corresponding sets of frequency domain carrier amplitudes ($X_0(k)$ to $X_N(k)$), where k is the OFDM symbol number, modulated as OFDM symbols to be transmitted from a transmitter, inserting prefixes as guard intervals in said sample streams, transmitting said OFDM symbols from said transmitter to a receiver, using information from said prefixes to estimate the Channel Impulse Response ($H_D^{(F)}$) of the transmission channels at the receiver, and using the estimated Channel Impulse Response ($\hat{H}_D^{(F)}$) to demodulate said bit streams in the signals received at said receiver,

   characterised in that said prefixes ($\alpha_k.c_0$ to $\alpha_k.c_{D-1}$) are deterministic and are known to said receiver as well as to said transmitter.

2. A method of communication as claimed in claim 1, wherein said prefixes ($\alpha_k.c_0$ to $\alpha_k.c_{D-1}$) comprise a vector (P_D) that is common to said symbols multiplied by at least one weighting factor (α_k).

3. A method of communication as claimed in claim 2, wherein said weighting factor (α_k) differs from one symbol to another but the elements of a given vector (P_D) are multiplied by the same weighting factor.

4. A method of communication as claimed in claim 3, wherein said weighting factor (α_k) has a pseudo-random value.

5. A method of communication as claimed in claim 1 or 2, wherein said weighting factor (α_k) is a complex value.

6. A method of communication as claimed in claim 5, wherein the modulus of said weighting factor (α_k) is constant from one symbol to another.

7. A method of communication as claimed in claim 6, wherein said weighting factor (α_k) is proportional to $e^{j\frac{2\pi}{N+D}\cdot m}$, where N is the useful OFDM symbol size, D is the size of the prefix vector and m is an integer.

8. A method of communication as claimed in any preceding claim, wherein estimating said Channel Impulse Response ($H_D^{(F)}$) comprises performing a Fourier Transform on a first vector (V_{HP}) that comprises the received signal components corresponding to one of said prefixes ($\alpha_k.c_0$ to $\alpha_k.c_{D-1}$) and also the received signal components corresponding to the following one of said prefixes ($\alpha_{k+1}.c_0$ to $\alpha_{k+1}.c_{D-1}$) to produce a received prefix signal transform ($V_{HP,F}$), performing a similar Fourier Transform on a second vector (V_P) that comprises the known values of corresponding components of said prefixes ($\alpha_k.c_0$ to $\alpha_k.c_{D-1}$, $\alpha_{k+1}.c_0$ to $\alpha_{k+1}.c_{D-1}$) to produce a known prefix transform ($V_{P,F}$), and performing a component-by-component division of the received prefix signal transform ($V_{HP,F}$) by the known prefix transform ($V_{P,F}$).

9. A method of communication as claimed in claim 8, wherein said prefixes comprise a vector (P_D) that is common to said symbols multiplied by weighting factors (α_k, α_{k+1}), said weighting factors differing from one symbol to another but the elements of a given vector being multiplied by the same weighting factor, and wherein the received signal components corresponding to said one of said prefixes ($\alpha_k.c_0$ to $\alpha_k.c_{D-1}$) and said following one of said prefixes ($\alpha_{k+1}.c_0$ to $\alpha_{k+1}.c_{D-1}$) are weighted by the respective value of said weighting factor (α_k, α_{k+1}) before summing and performing said Fourier Transform to produce said received prefix signal transform ($V_{HP,F}$).

10. A method of communication as claimed in claim 8 or 9, wherein said Fourier Transforms are of dimension DxD, where D is the size of said prefixes ($c_0.\alpha_k$ to $c_{D-1}.\alpha_k$).

11. A method of communication as claimed in claim 8 or 9, wherein said Fourier Transforms are of dimension $(D+N)x(D+N)$, where D is the size of said prefixes ($\alpha_k.c_0$ to $\alpha_k.c_{D-1}$) and N is the size of the OFDM signals between said prefixes, said first vector (V_{HP}) comprises said sum of said received signal components

corresponding to one of said prefixes ($\alpha_k.c_0$ to $\alpha_k.c_{D-1}$) and of the following one of said prefixes ($\alpha_{k+1}.c_0$ to $\alpha_{k+1}.c_{D-1}$) augmented by a zero value vector (0_N^T) of size *(N)* to produce said received prefix signal transform ($V_{HP,F}$) of size *(N+D)*, and said second vector (V_P) comprises said known components of said prefixes (($\alpha_k.c_0$ to $\alpha_k.c_{D-1}$, $\alpha_{k+1}.c_0$ to $\alpha_{k+1}.c_{D-1}$) augmented by said zero value vector (0_N^T) of size *(N)* to produce said known prefix transform ($V_{P,F}$) of size *(N+D)*.

12. A method of communication as claimed in any preceding claim, wherein estimating said Channel Impulse Response ($H_D^{(F)}$) comprises combining information from said prefixes ($\alpha_k.c_0$ to $\alpha_k.c_{D-1}$, $\alpha_{k+1}.c_0$ to $\alpha_{k+1}.c_{D-1}$) for more than one symbol to obtain said estimated Channel Impulse Response ($\hat{H}_D^{(F)}$).

13. A method of communication as claimed in any preceding claim, wherein demodulating said bit streams comprises:
    - performing the multiplication by a matrix proportional to $R^{(1)}(k)=\sqrt{N+D}\cdot\left[\hat{V}\right]\cdot r(k)$, where
    $$\left[\hat{V}\right]=\left(\sum_{n=0}^{N+D-1}\left|\beta_k\right|^{\frac{2n}{N+D}}\right)^{-\frac{1}{2}}\cdot\left[F_{N+D}\right]\cdot diag\left\{1,\beta_k^{\frac{1}{N+D}},\ldots,\beta_k^{\frac{N+D-1}{N+D}}\right\},\beta_k=\frac{\alpha_k}{\alpha_{k+1}}.$$
    - calculating the frequency shifted CIR coefficients
    $$\hat{H}_{N+D}^{Shifted,F}=\left(\hat{H}\left(\beta_k^{\frac{1}{N+D}}\right),\ldots,\hat{H}\left(\beta_k^{\frac{1}{N+D}}\cdot e^{j2\pi\cdot\frac{N+D-1}{N+D}}\right)\right),\beta_k=\frac{\alpha_k}{\alpha_{k+1}}.,$$
    - performing a component-by-component division $R^{(2)}(k)=R^{(1)}(k)\oslash\hat{H}_{N+D}^{Shifted,F}$,
    - performing a multiplication by a matrix proportional to $R^{(3)}(k)=\left[\hat{V}\right]^{-1}\cdot\frac{1}{\sqrt{N+D}}\cdot R^{(2)}(k).,$
    - extracting the *N* equalized samples corresponding to the k^{th} data symbol to the vector $S^{EQ}(k)$, and
    - transforming the symbol $\hat{s}(k)$ into frequency domain by performing a Fourier Transform: $S_F^{EQ}(k)=[F_{N\times N}]\cdot S^{EQ}(k)$.

14. A method of communication as claimed in any of claims 1 to 12, wherein demodulating said bit streams includes padding the received signal matrix and the operator matrices with zeros to obtain compatible dimensions for the subsequent operations, multiplying the known prefix value matrix by the Channel Impulse Response estimation matrix and subtracting the result from the received signal matrix.

15. A transmitter for use in a method of communication as claimed in any preceding claim and comprising generating means for generating bit streams $b_n \in (0,1), n = 0,1,\ldots,K-1$ modulated as OFDM symbols to be transmitted and inserting prefixes as guard intervals between said OFDM symbols, said prefixes ($\alpha_k.c_0$ to $\alpha_k.c_{D-1}$) being deterministic and suitable to be known to said receiver as well as to said transmitter.

16. A receiver for use in a method of communication as claimed in any of claims 1 to 14 and comprising demodulating means for receiving signals that comprise bit streams $b_n \in (0,1), n = 0,1,\ldots,K-1$ modulated as OFDM symbols to be transmitted from a transmitter, with prefixes inserted in guard intervals between said OFDM symbols, said OFDM symbols having been transmitted from said transmitter to said receiver, said demodulating means being arranged to use information from said prefixes to estimate the Channel Impulse Response ($H_D^{(F)}$) of the transmission channels and to use the estimated Channel Impulse Response ($\hat{H}_D^{(F)}$) to demodulate said bit streams in the signals received at said receiver, said prefixes ($\alpha_k.c_0$ to $\alpha_k.c_{D-1}$) being deterministic and being known to said receiver as well as to said transmitter.